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CURRENT LITERATURE

BOOK REVIEWS

The organism as a whole

The author of this book[1] in his previous writings has concerned himself with particular processes and activities of the organism, but has never given us any adequate consideration of that remarkable order and harmony which make the organism a whole and not merely an aggregate of parts. The title of the book arouses the hope and justifies the expectation that we shall find in it something in the way of a synthesis or some attempt at least to formulate the problem of organic order and harmony in physico-chemical terms. To what extent the book accomplishes this will appear more clearly as we consider its contents.

In the preface the author says, "in this book an attempt is made to show that the unity of the organism is due to the fact that the egg (or rather its cytoplasm) is the future embryo, upon which the Mendelian factors in the chromosomes can impress only individual characteristics, probably by giving rise to special hormones and enzymes." Apparently this conception of the egg cytoplasm and chromosomes is the chief thesis of the book, for it is stated repeatedly in almost the same words. By way of proof, some well known cases of visible cytoplasmic differentiation in animal eggs are cited and their apparent relation to the future embryo is pointed out, but as regards the action of the Mendelian factors the reviewer has not been able to find anything except surmises, suggestions, and opinions, and these do not carry us beyond the original statement. Moreover, no attempt is made to show how the unity of the organism results from this situation in the egg or how the situation itself arises. As LOEB states it, the case looks amazingly like one of pre-established harmony. The cytoplasmic differentiations are there and the Mendelian factors are there, apparently without any previous relation to each other, and it does not appear how they have come to be there. It is difficult to discover where the unity lies.

The second thesis of the book seems to be that the existence of purposeful and harmonious organisms is explicable in mechanistic terms on the basis of evolutionary theory, provided we substitute the De Vriesian for the Darwinian conception. In support of this thesis the stock arguments are presented: (1) that mutations are inherited, while fluctuating variations are not; and

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[1] LOEB, JACQUES, The organism as a whole from a physico-chemical viewpoint. pp. viii+379. New York: Putnam Sons. 1916.

(2) that organisms which are not purposeful and harmonious cannot persist. We look in vain for any consideration of the organism as a whole, that is, of the nature of its wholeness. There is no discussion of the morphological problem, but structure is simply accepted or assumed as required, and the author is chiefly concerned with certain chemical aspects of life.

If, however, the book is not exactly what its title leads us to expect, it nevertheless contains a great variety of facts, suggestions, and hypotheses concerning many aspects of biology, and these are all presented in the author's usual interesting and persuasive style. It is quite impossible even to mention all the various fields which the author enters, but a brief survey of chapters will indicate the range of the book.

In an introductory chapter CLAUDE BERNARD'S "design," DRIESCH'S "entelechy," and VON UEXKÜLL'S "supergenes" are briefly considered and discarded as superfluous.

The contents of the second chapter are indicated by its title: "The specific difference between living and dead matter and the question of the origin of life." LOEB refutes very effectively the argument for a fundamental similarity between organisms and crystals. The organism differs from the crystal and other inorganic systems in that it synthesizes its own specific substance out of non-specific materials. He then argues for the immortality of the body cell, but without discussion of the phenomena of senescence, and finally reaches the conclusion that life is either eternal or that there must be synthetic enzymes which form molecules of themselves from a nutritive solution. Apparently he fails to see that such enzymes offer no solution of the problem of the origin of life, for, according to his own definition of living things, these enzymes must themselves be alive.

The third chapter, "The chemical basis of genus and species," discusses specificity in grafting, blood and serum specificity, etc., and concludes that the basis of specificity is in the proteins. The next two chapters, "Specificity in fertilization" and "Artificial parthenogenesis," are in large measure an account of the work of LOEB and his students, and contain little of importance that has not already appeared in the author's earlier books. Recent work on the problem by F. R. and R. S. LILLIE and others is briefly mentioned, but the author's conclusions remain essentially unaltered.

The sixth chapter, "Determinism in the formation of an organism from an egg," is an argument in support of the view that the egg cytoplasm is the embryo in the rough. The cases of visible cytoplasmic differentiation in animal eggs and its apparent relation to later development are cited, but no mention is made of the centrifuge experiments which demonstrated that, in most cases at least, this visible differentiation is not an essential feature in further development. After some consideration of the development of isolated blastomeres, LOEB concludes that the only regulation in the egg consists in a flow of materials, but he neglects to account for the remarkably orderly character of the flow.

Following is a chapter on "Regeneration," which begins with a statement of SACH'S theory of formative substances. The reviewer finds much to criticize in this chapter, since his own work in this field has led him to very different conclusions from those reached by LOEB, but only a few points of more general interest need be noted here. Special substances are postulated to account for all phenomena of regeneration, there is no adequate discussion of nor even reference to other hypotheses, and most of the experiments cited are those of LOEB and his students. In the discussion of regeneration in plants only the author's experiments on *Bryophyllum* are mentioned. One would never even suspect from reading the book that the problem of regeneration or experimental reproduction had ever received any attention from the botanists. MCCALLUM'S work is completely ignored. In the case of *Bryophyllum*, which is discussed at some length, LOEB'S argument is briefly this: certain substances determine the growth of a particular organ, for example, a growing tip, and the growing organ attracts these substances. In other words, the substances are necessary to make the organ grow, while on the other hand, it must begin to grow in order to obtain these substances. These substances are assumed to be in the fluids of the body and to be carried by these except in so far as they are "attracted" by particular growing tips. If this is the case, how is it possible that one growing tip can prevent another, perhaps in its immediate vicinity, from obtaining *any* of the substance necessary for its growth? But this is what LOEB assumes and asks us to believe.

In discussing certain experiments on *Planaria*, BARDEEN'S earlier conclusions are accepted and no mention is made of the fact that BARDEEN himself showed in later work that they were incorrect, and that more recent work has still further demonstrated that the factors concerned are very different from those which LOEB postulates. The author's experiments, made some 25 years ago, on the effect of gravity in determining the polarity of the hydroid *Antennularia* are described, but there is no discussion or even mention of the fact that other investigators have been quite unable to confirm them.

The flow of substances, assumed by LOEB to occur in pieces of the stem of the hydroid *Tubularia* toward one pole or the other as the facts of regeneration demand, is entirely without any basis of evidence, and the simultaneous regeneration of hydranths or partial hydranths at both ends of a short piece with no stem between them presents difficulties to this interpretation. Since the short piece produces hydranths and these hydranths occupy its whole length, it must have contained enough of the formative substances to produce them. If this is the case, why is any flow from other parts necessary for the production of a hydranth in longer pieces, as the hydranth-forming region must have enough of it to develop a hydranth? Moreover, if a short piece of the stem can transform itself completely into one or more hydranths or partial hydranths without the presence of other parts, how can the development of the hydranth be determined by the influence of other parts, as LOEB maintains? Further criticisms of this chapter might be made, but perhaps these are sufficient to show that LOEB'S interpretations throw no light on the problem.

Chapter VIII, "Determination of sex, secondary sexual characters, and sexual instincts," deals first with the cytological basis of sex-determination. LOEB accepts in their most extreme form the conclusions of the cytologists concerning the "sex-chromosomes," and says that "thus far all the facts agree with the dominating influence of certain chromosomes upon sex-determination." Actually, however, these facts, assuming that they are all facts, have been interpreted very differently by different authors. Sex-determination in plants is mentioned in only two brief sentences. The discussion of the physiological basis of sex-determination is largely concerned with sex-hormones, experimental and parasitic castration, and the influence of nutrition on sex. The intersexual forms of the moth *Lymantria* obtained by GOLDSCHMIDT are described, but without comment.

The account of "Mendelian heredity and its mechanism" in chapter IX begins with a brief outline of Mendelian theory and of MORGAN'S hypothesis of localization of the Mendelian factors in the chromosome, concluding with the statement "biology has thus reached in the chromosome theory of Mendelian heredity an atomistic conception, according to which independent material determiners for hereditary characters exist in a linear arrangement in the chromosome." The author then inquires "what makes a harmonious organism out of this kaleidoscopic assortment?" The answer is that the egg cytoplasm is the embryo in the rough, and that each determiner in the chromosomes gives rise to one or more substances which influence various parts of the body. But when we ask how the egg cytoplasm comes to be the embryo, and in the rough, and how it happens that the substances produced are adjusted to the different regions of the cytoplasm, we find no answer except the assertion that evolution can produce harmonious organisms, because those that are not harmonious are eliminated.

Chapter X on "Animal instincts and tropisms" adds nothing essential to LOEB'S previous discussion of the subject, and is open to the same criticisms. The chapter is devoted largely to the consideration of reactions to light and the attempt to show that they are in accord with the Bunsen-Roscoe law of photochemical reactions, according to which the chemical effect is within certain limits equal to the product of intensity into duration of illumination. There is but little discussion of fact or theory which does not agree with LOEB'S conclusions. As regards the trial and error theory, LOEB says that it has been refuted by practically all workers in the field. Students of animal behavior will be interested to discover that the question has been settled.

"The influence of environment," chapter XI, is devoted largely to consideration of the influence of temperature, the temperature coefficient of physiological processes, salt antagonisms, and balanced solutions. This is followed by a chapter on "Adaptation to environment," which is somewhat less extreme than some of the author's earlier discussions of the subject, but in which his skepticism as to the occurrence of adaptation is clearly evident. LOEB seems to believe that if a case of apparent adaptation can be stated in terms of the action of particular substances on particular parts or stages, it is thereby removed from the category of adaptation. Actually of course this line of reasoning does not touch the real problem, for the harmonious relations between substance and organ of apparent specificity, time, or intensity of action, may themselves be adaptations. A chapter on "Evolution," consisting of three pages, is little more than an acceptance of the De Vriesian as opposed to the Darwinian conception of the mechanism of evolution.

The final chapter, "Death and dissolution of the organism," begins with an interesting consideration of autolysis and its relation to the cessation of oxidations, lack of oxygen, and change in hydrogen ion concentration. Death in the higher animals, he says, is due to cessation of oxidations. The statement "it is an unquestionable fact that each form has a quite definite duration of life" is not in agreement with recent experimental work on some of the lower animals, and to say that "no species can exist unless the natural life of its individuals outlasts the period of sexual maturity" is to ignore the fact that various forms, not only among the protozoa which LOEB regards as immortal, exist for many generations, probably indefinitely, with only agamic reproduction. Are such forms also immortal? As regards the protozoa, however, he fails to note that the "immortality" depends upon reproduction. Any protoplasm concerned in reproduction is just as immortal as protozoan protoplasm. This sort of immortality depends upon the processes of rejuvenescence associated with reproduction, and is merely the continuity of life through the reproductive process. As might be expected from the suggestion in chapter II that the body cell is immortal, LOEB agrees with METCHNIKOFF in regarding senescence and death as essentially an accident due to the formation in the body of poisons through bacterial action or otherwise. Special chemical substances are the cause of death as well as of most of the phenomena of life.

This then is apparently LOEB's conception of the organism as a whole, a "kaleidoscopic assortment" of material factors or determiners located in the chromosomes, producing substances which act on another assortment of materials in the cytoplasm. In chapter II he says "biology will be scientific only to the extent that it succeeds in reducing life phenomena to quantitative laws." Nevertheless, his interpretations are predominantly qualitative, and in various cases he has ignored quantitative interpretations offered by others. We find, for example, no mention even by way of refutation of RIDDLE's quantitative hypothesis of sex. The evidence in favor of a quantitative conception of polarity and of initiation of differentiation is not considered, and no mention is made of the quantitative hypotheses of senescence, which, by the way, can be interpreted in terms which are completely in accord with the autocatalytic theory of growth in favor of which LOEB has repeatedly declared himself. There seems to be a certain inconsistency in this preference for qualitative interpretations. If scientific biology is essentially quantitative, as LOEB maintains, we have the right to demand adequate grounds for his rejection or failure to discuss quantitative as opposed to qualitative interpretations.

Few biologists of the present day will deny the importance of chemical or transportative correlation, that is, the production, transportation, and action in the organism of chemical substances, many of which are supposed to be specific. There is, however, another sort of physiological correlation, namely, transmissive or conductive correlation, which finds its highest development in the nervous system. In this sort of correlation the essential feature is the transmission of energy rather than the transportation of materials. There can be no doubt that in organisms which possess a differentiated nervous system this is the chief factor in maintaining the integration of the organism as a harmonious whole. But biologists are very generally agreed that the nervous system adds nothing new to the organism, for transmissive correlation exists even where there is no visibly differentiated nervous system. In fact, the nervous system is the structural and functional expression of transmissive relations between parts which exist both embryologically and phylogenetically before its development. Unless we assume the existence of an entelechy or supergenes or some other non-mechanistic ordering and controlling principle, we cannot escape the conclusion that the starting-point of physiological integration is to be found in the initiation and transmission from one part to another of dynamic changes, not of material substances.

In a discussion of the organism as a whole we should expect to find something concerning the nervous system, and how it has become of such importance in physiological integration. LOEB, however, merely refers in the preface to his "comparative physiology of the brain" as supplementing the present book. The German edition of that work appeared in 1899. It seems to many of us that after 18 years there might at least be something to add to the original discussion, particularly as regards the integrating function of the nervous system or of protoplasmic conduction in general. Apparently, however, transmission, conduction, and nervous function possess no fundamental significance for the author in relation to the wholeness of the organism.

The analogy between the biological individual, the organism, and the social organism, the state, has often been noted both by biologists and sociologists. The reviewer believes that there is more than an analogy here. Both the organism and human society represent the reactions of living protoplasm to its environment, and in the integration of human individuals into an orderly and harmonious whole we find a fundamental similarity to the process of physiological integration within the organism. A moment's thought is sufficient to show that in the integration of human beings into an orderly community or state the transmissive relations are the primary factors. The production and interchange of substances among human beings, which we know as barter and exchange or commerce, can never of itself integrate those concerned into an orderly and harmonious whole, a tribe or nation. Government of some sort, that is, authority and its transmission, is the real integrating factor, and commercial relations do not assume an orderly harmonious character until at least some degree of integration has taken place.

LOEB is attempting to conceive the organism as a whole in terms of the commercial relations between its parts. This is as if one should attempt to interpret a nation or state and its origin in terms of the production and exchange of commodities between its constituent members or groups. The one attempt is as futile as the other. Actually LOEB has failed to see the organism as a whole because he has been so engrossed with the particular activities of its various parts and their relation to environment. Evidence is rapidly accumulating to show that control, that is, government in the organism, is a physiological fact, and the primary fact in the integration of the individual, that such control originates in quantitative differences in the velocity of metabolic reactions and the associated protoplasmic differences together with the transmission of energy changes resulting from these differences rather than in the transportation of substances, and that the nervous system is morphologically and physiologically merely the expression of the transmissive relations which exist from the beginning of individuation. This conception is not only supported by many lines of evidence, but it comes much nearer LOEB's definition of scientific biology as the reduction of life phenomena to quantitative laws than does his own interpretation in terms of formative or nutritive substances. Certainly the egg is the embryo in the rough, as LOEB maintains, and so is any other reproductive cell or cell mass, but since the embryo and the organism developing from it are orderly and harmonious wholes, the egg and other reproductive bodies must also be wholes of the same sort. It is here that we come face to face with the problem of the organism as a whole, and LOEB offers us nothing but the bare assertion, oft repeated, that the egg is the embryo in the rough, and this is merely the statement of the problem, not the solution. He has contented himself with this mere statement of the real problem and has passed on to devote himself to the innumerable details of the activity of the organism in which the wholeness is already established and effective. If this were all that mechanistic biology has to offer toward the solution of the problem of the organism, the vitalist might rest content.

If we search in vain for the organism as a whole in the book, however, there is nevertheless much of interest. It must be admitted that those familiar with LOEB's earlier books will find little that is new, particularly in certain chapters, and that often there is no consideration of the work of others, but, as a statement of LOEB's conception of the organism, the book cannot fail to interest the biologist, even though, or perhaps because, he will find himself unable to assent to many of its conclusions.—C. M. CHILD.